Cells $\xrightarrow{\text{utilise}}$ O_2 $\xrightarrow{\text{for}}$ metabolism → produce energy → along with substances like → CO_2 → harmful

Breathing & Exchange Of Gases

Exchange of O_2 from atm with CO_2 prod. by cells
↳ Breathing

Mech. of breathing $\xrightarrow[\text{on}]{\text{based}}$ Habitat / level of org.

- Simple diffusion over entire body surface
  - Lower invertebr.
  - Sponges
  - Coelenterate
  - Flatworms
- Moist Cuticle
  - Earthworm
- Gills (Branchial Resp)
  - aquatic arthropod & molluscs
- Lungs (Pulmonary resp)
  - Terrestrial forms

Vertebrate
- Fishes (gills)
- Reptile, Amphibian, Birds, Mammals } Lung

Amphibian → Frog
Respire through moist skin
Cutaneous Respiration

Lungs $\xrightarrow{\text{Inside}}$ Anatomically air tight chamber (Thoracic chamber)

↓ formed

Dorsally by : Vertebral column
Ventrally : Sternum
Laterally : Ribs
Lowerside : "Dome-shaped" Diaphragm.

The anatomical set up of lungs in thorax is such that any change in the volume of thoracic cavity will be reflected in lung (pulmonary) cavity. Such an arrangement is essential for breathing, as we cannot directly alter pulmonary volume.

Respiration steps ⟶ Breathing or pulmonary ventilation (atm. air (O_2) ⟶ in ; alveolar air (CO_2) ⟶ out)

↓

Diffusion of gases across alveolar memb.

↓

Transport of gases by blood.

←

Diffusion of O_2 & CO_2 b/w blood & tissues

←

utilisation of O_2 by cells for catabolic rxn & release CO_2

- Clears air from foreign particles
- Humidifies
- Bring to body temp

HUMAN RESPIRATORY SYSTEM →

CONDUCTING PART

Pair of external nostrils (above the upper lip)

↓ through nasal passage

Leads to nasal chamber.

↓

pharynx. (common for food & air)

↓

Larynx region — cartilagenous box → sound production. (sound box)

↓ into

Trachea. (~~straight tube~~ extending upto mid thoracic cavity)

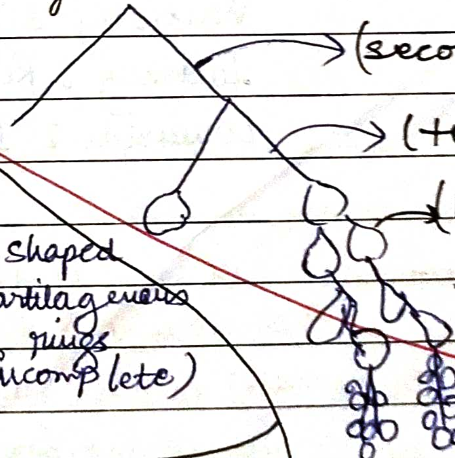
During swallowing, glottis is covered by thin elastic cartilag. flap; epiglottis to prevent the entry of food into the larynx.

divides at the level of T_5.

LUNGS

actual diffusion occurs here

Right bronchi — Left bronchi (Primary)



→ (secondary bronchi)

→ (tertiary bronchi)

→ (Bronchioles)

↓

Terminal Bronchiole (thin)

↓

Alveoli (thin, irregular walled vascularized bag)] Resp or Exchange part

* Trachea, Primary, Sec., Tert. } Bronchi, Initial bronchioles → C shaped cartilagenous rings (incomplete)

LUNGS (from bronchi to alveoli)

Covered by double layered pleura with pleural fluid b/w them.

↳ reduces friction on lung surface

Outer pleura → contact with thoracic lining

inner pleura → contact with lungs surface

by creating a pressure gradient b/w the lungs & the atmosphere.

MECHANISM OF BREATHING

Inspiration	Expiration
Atmospheric ~~Atm.~~ air → in	Alveolar ~~Atm~~ air → out
Intra-pulmonary pressure < Atm. pressure	Intra pulm. pressure > Atm. pressure.
i.e	i.e
−Ve pressure in lungs w.r.t w.r.t atmosph. pressure.	+Ve pressure in lungs w.r.t atmosph. pressure.

The diaphragm, specialised set of muscle – external & internal intercoastal b/w the ribs.

Inspiration:

- Contraction of diaphragm
- ↓
- Volume of thoracic chamber ↑ (Antero posterior axis)
- ↓
- Contraction of external inter ~~coastal muscle lifts up the Ribs~~ & sternum causing
- ↓
- Volume of thoracic chamber ↑ (dorso ventral axis)
- ↓
- Pulmonary Vol. ↑
- ↓
- Intra pulmonary pressure ↓
- ↓
- Inspiration

We have the ability to increase the strength of insp. & exp. with the help of additional muscles in abdomen.

Expiration:

- Relaxation of diaphragm
- ↓
- Relaxation of external intercoastal muscles.
- ↓
- Diaphragm & sternum returns back to orig. post.
- ↓
- Thoracic Volume ↓
- ↓
- Pulmonary Volume ↓
- ↓
- Intra pulmonary pressure ↑
- ↓
- Expiration

Breathing Rate ⇒ 12-16 times/ per min

alveoli $\xrightarrow{b/w}$ blood & tissues

EXCHANGE OF GASES.

Alveoli → primary sites of exchange of gases;
b/w blood & tissues

O_2 CO_2

By simple diffusion. ←

based on.

→ pressure / conc. gradient.
→ Solubility of gases
→ Thickness of membranes.
→ affect rate of diffusion

Partial pressure → Pressure exerted by individual Gases in a mixture of gases.

	Atm. air	Alveoli	Blood (deoxyg.)	Blood (Oxyg.)	Tissues
O_2	159	104	40	95	40
CO_2	0.3	40	45	40	45

45 (Blood deoxyg.) → pulmonary artery.
40 (Blood oxyg.) → pulmonary vein.

- Gradient for oxygen – from alveoli to blood & blood to tissue
- Gradeint for CO_2 – from tissue to blood & blood to alveoli

* Solubility of CO_2 is 20-25 times ↑ than that of O_2.
hence the amt. of CO_2 that can diffuse through diffusion membrane per unit difference in partial press. is higher than that of O_2.

thickness < 1mm. ← diffusion membrane

- thin Squamous epithelium of alveoli
- (single endothelium cell layer) of alveolar cappillaries
- Basement Substance ~~Membrane~~ (composed of thin basement membrane supporting the squamous epithelium & basement membr. surrounding the single layer endothelial cells of capillaries) in b/w

TRANSPORT OF GASES.

Medium : Blood.

O_2

By RBC : 97% (as oxyhaemoglobin)
By plasma : 3%
↳ by dissolved state

Transport of O_2

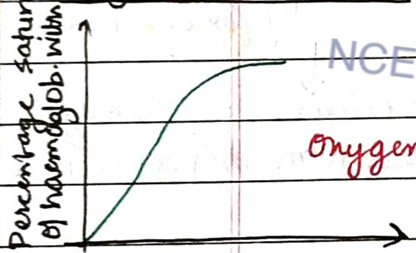
Haemog. $\xrightarrow{\text{inside}}$ RBC

binds in reversible manner with O_2.

* 1 Haemaglob. $\xrightarrow{\text{carries}}$ 4 molecule of O_2.

* Binding of O_2 is primarily related to pO_2 but pCO_2, pH & temp also plays an important role.

Sigmoid Curve



Oxygen dissociation curve.
↓
Highly useful in studying the effect of factors like pCO_2, H^+ conc. on binding of O_2 with haemogl.

For formation of haemogl. oxy (HbO_2)	For dissociation of HbO_2
pO_2 ↑	pO_2 ↓
pCO_2 ↓	pCO_2 ↑
pH ↑ (H^+ ↓)	pH ↓ (H^+ ↑)
temp ↓	temp ↑
In alveoli (lung surface)	In tissues

* Every 100 ml of oxygenated blood can deliver 5 ml of O_2 → tissue (under normal physiological cond.)

CO_2

By RBC : 20–25% (as carbamino haemoglobin)
By Bicarbonate : 70%.
By plasma : 7%
↳ in dissolved state

Transport of CO_2.

The binding with haemoglobin is related to pCO_2, pO_2 is a major factor, affecting this binding

For form. of $HbCO_2$.	For dissociation
pCO_2 ↑	pCO_2 ↓
pO_2 ↓	pO_2 ↑
In tissues.	In alveoli

RBC $\xrightarrow{\text{contains}}$ Carbonic Anhydrase (C.A) ← minute quantity Plasma.

facilitates in both direc.

$$CO_2 + H_2O \overset{C.A}{\rightleftharpoons} H_2CO_3 \overset{C.A}{\rightleftharpoons} HCO_3^- + H^+$$

At tissue ⟶ pCO_2 ↑ (due to metabolism) ⟶ CO_2 diffuses into RBC & plasma, forms HCO_3^- & H^+ (bicarbonate) trapped

At alveolar site ⟶ pCO_2 ↓ ⟶ CO_2 & H_2O formed

* Every 100 ml of deoxygenated blood delivers 4 ml of CO_2 to alveoli.

Date
Page

Disorders of Resp. Syst.

Asthma
Difficulty in breathing
↓ causing
Wheezing
↓ due to
Inflamm. in bronchi & bronchioles

Emphysema
Chronic disorder
↓
alveolar walls are damaged
↓ due to which
Resp. surface ↓
Caused due to: Cigarette smoking

Occupat. Resp. Disorders
In industries, where involves grinding or stone breaking
↓
so much dust is prod.
↓ so that
defense mech. of body cannot fully cope up with situation.
Long exposure
↓
inflammation.
↓ leading to
Fibroses (proliferation of fibrous tissue)
↓
serious lung damage.
* Workers should wear protective mask

REGULATION OF RESPIRATION.
Humans → signf. ability to maintain & regulate → Resp. rythm
done by neural system.

* Role of O_2 is reg. of resp. rythm quite insignificant.

Respiratory Rythm Centre → Specialised centre
maintains respiratory rythm
In medulla (in brain)
Primarily responsible for its regulation

can alter respiratory mechanism

Pneumotaxic Centre → In pons (in brain)
Moderate the functions of respiratory rythm centre.
↓ neural signal from pneumotaxic centre.
Reduce the duration of inspiration & thereby → alter respiratory rate.

Chemosensitive area
↓
Adjacent to rythm centre.
Highly sensitive to CO_2 & H^+
↓ Increase in these centre activates
signals
Rythm centre
↓ make necessary adjustments in resp. process
these subst. eliminated

Receptors associated Aortic arch & Carotid artery → recognize changes in CO_2 & H^+ conc.
signals → Rythm centre → Remedial action

Volumes & Capacities

Clinical Significance

The volume of air involved in breathing movem. can be estimated by spirometer, which helps in clinical assessment of pulmonary functions

Tidal Volume ↓ In 1 hr ↓ 3,60,000 ml — 4,80,000 ml (360 L — 480 L)	500 mL	Volume of air inspired or expired during normal resp. Healthy man can inspire /expire approx. 6000 - 8000 mL air/min
IRV	2500 - 3000 mL	Additional volume of air, a person can inspire by a forcible inspiration
ERV	1000 - 1100 mL	Additional volume of air, a person can expire by forcible expiration.
RV	1100 - 1200 mL	Volume of air in lungs after forcible expiration

By adding up a few respiratory volumes, one can derive capacities

↳ helps in clinical diagnosis.

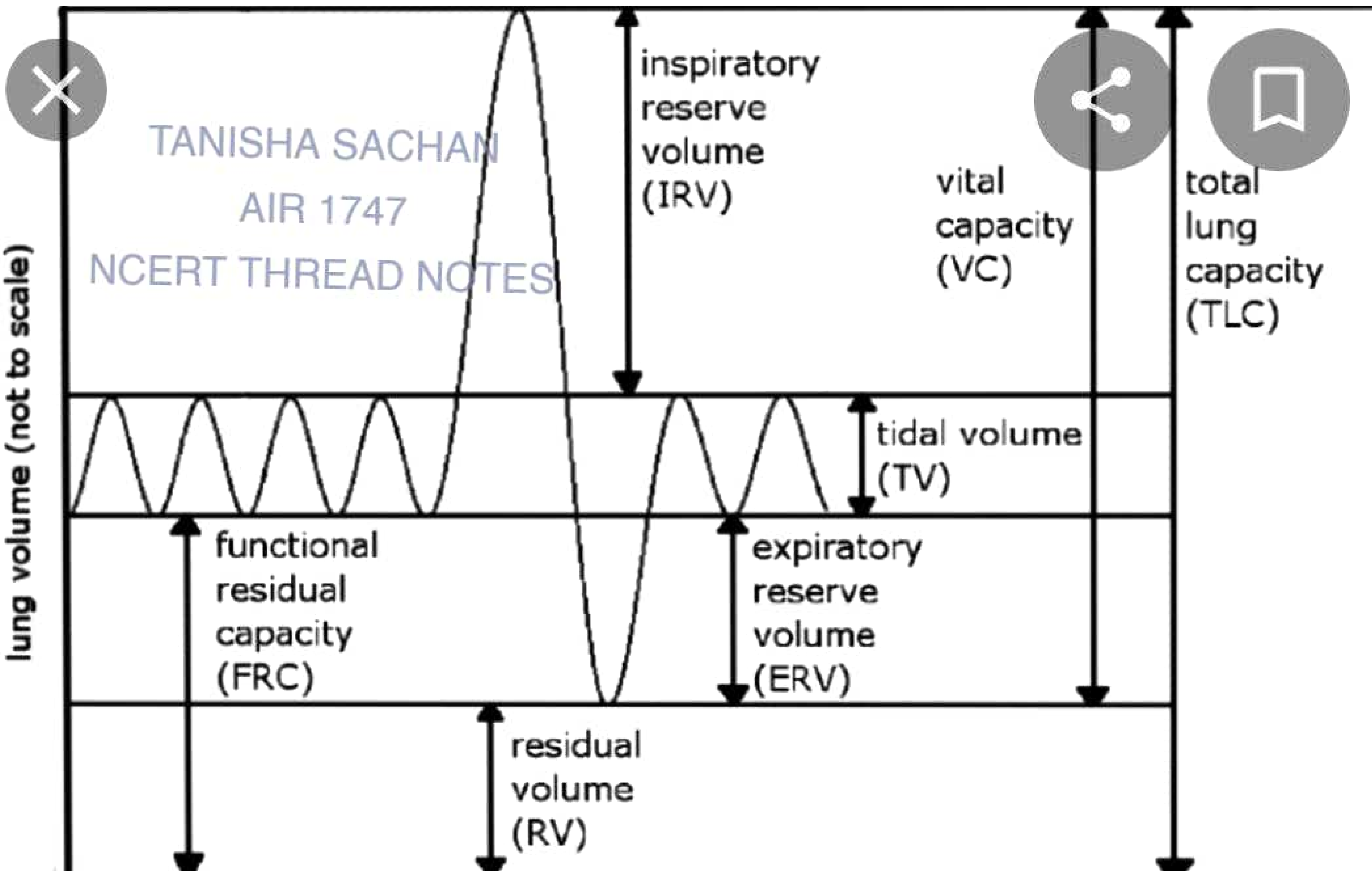
IC	TV + IRV (3000 - 3500 mL)	Total volume of a person can inspire after a normal expiration.
EC	TV + ERV (1500 - 1600 mL)	Total volume of air person can expire after normal inspiration

FRC	ERV + RV 2100 – 3300 ml	Volume of air remained in lungs after normal expiration.
VC	ERV + TV + IRV	Breath in total after forced expiration / breath out total after forced inspiration
TC	RV + ERV + TV + IRV (Vital capacity + RV)	total vol. of air accomod. in lungs at the end of forced inspiration.

Significance
↓
Max^{m} amt of air that can be converted / renewed in Respiratory system in single Respiration.

Hypoxia → In CO poisoning
Pathological cond where whole body or part is not supplied with enough O_2.

	Atmospheric air	Alveolar air
pO_2	↑ (higher)	↓ (lower)
pCO_2	↓ (lower)	↑ (higher)



lung volume (not to scale)
TANISHA SACHAN
AIR 1747
NCERT THREAD NOTES
inspiratory reserve volume (IRV)
vital capacity (VC)
total lung capacity (TLC)
tidal volume (TV)
functional residual capacity (FRC)
expiratory reserve volume (ERV)
residual volume (RV)